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APPLICATION NUMBER: ***60/505,146***
FILING DATE: ***September 23, 2003***
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THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS ***US60/505,146***

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19587 U.S. PTO
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

Express Mail Label N . EL995079042US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Cristina	Gomila	Princeton, New Jersey
Joan	Llach	Princeton, New Jersey

☒ *Additional inventors are being named on the 1 separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

A METHOD FOR SIMULATING FILM GRAIN BY MOSAICING A SERIES OF PRE-COMPUTED SAMPLES

CORRESPONDENCE ADDRESS

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Country	USA — Telephone: 609-734-6834 — Fax: 609-734-6888

ENCLOSED APPLICATION PARTS ***(check all that apply)***

☒ Specification *Number of Pages* 9 ☐ CD(s), Number

☐ Drawing(s) *Number of Sheets* ☐ Other (specify)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 07-0832

FILING FEE AMOUNT ($) 160

☐ Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____.

Respectfully submitted,

SIGNATURE [signature]

Date 9/23/03

TYPED or PRINTED NAME Robert B. Levy

REGISTRATION NO. (*if appropriate*) 28,234

TELEPHONE 609 734-6820

Docket Number: PU030274

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIONAL APPLICATION COVER SHEET
Additional Page

PTO/SB/16 (02-01)
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Docket Number	PU030274	Type a plus sign (+) inside this box →	+

INVENTOR(S)/APPLICANT(S)

Given Name (first and middle [if any])	Family or Surname	Residence (City and either State or Foreign Country)
Jill MacDonald	Boyce	Manalapan, New Jersey

Number 2 of 2

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FEE TRANSMITTAL for FY 2003

Effective 01/01/2003. Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 160

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Application Number	
Filing Date	
First Named Inventor	Cristina Gomila
Examiner Name	
Group / Art Unit	
Attorney Docket No.	PU030274

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number	07-0832
Deposit Account Name	Thomson Licensing Inc.

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	750	2001	375	Utility filing fee	
1002	330	2002	165	Design filing fee	
1003	520	2003	260	Plant filing fee	
1004	750	2004	375	Reissue filing fee	
1005	160	2005	80	Provisional filling fee	160

SUBTOTAL (1) ($) 160

2. EXTRA CLAIM FEES

			Extra Claims		Fee from below		Fee Paid
Total Claims		-20 ** =	0	X		=	0
Independent Claims		-3 ** =	0	X		=	0
Multiple Dependent				X		=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	84	2201	42	Independent claims in excess of 3
1203	280	2203	140	Multiple dependent claim, if not paid
1204	84	2204	42	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	410	2252	205	Extension for reply within second month	
1253	930	2253	465	Extension for reply within third month	
1254	1,450	2254	725	Extension for reply within fourth month	
1255	1,970	2255	985	Extension for reply within fifth month	
1401	320	2401	160	Notice of Appeal	
1402	320	2402	160	Filing a brief in support of an appeal	
1403	280	2403	140	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive – unavoidable	
1453	1,300	2453	650	Petition to revive – unintentional	
1501	1,300	2501	650	Utility issue fee (or reissue)	
1502	470	2502	235	Design issue fee	
1503	630	2503	315	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17 (q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	750	2809	375	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	750	2810	375	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	750	2801	375	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) ____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 0

SUBMITTED BY				Complete *(if applicable)*	
Name (Print/Type)	Robert B. Levy	Registration No. Attorney/Agent)	28,234	*Telephone*	609-734-6820
Signature				*Date*	September 23, 2003

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PU030274

A. Brief summary of the invention

In this invention, we propose an efficient implementation of the film grain simulation algorithm described in [1,2,3]. In particular, we propose to limit the film grain generation process to an initialization step in which a pool of film grain blocks is formed. The pool of blocks could provide different film grain samples for different color components and for different intensity levels if required by the model used to simulate the film grain.
This approach avoids the generation of film grain for blending with every processed block of pixels from the input image. As a result, it strongly reduces the computational complexity of the film grain simulation process.

B. Keywords: list keywords or combinations of keywords to guide patent and literature searches. Underline the most important keywords.

Film grain simulation, SEI message, JVT, MPEG-4 AVC, H.264.

C. Brief discussion of the problem solved by the invention.

In previous disclosures [3,4], we proposed a method for encoding film grain as supplemental enhancement information for a coded sequence. More specifically, we proposed (1) to filter grain out of images before compression, then (2) transmit compressed video together with a message containing information about original grain, and finally (3) let the decoder restore original grainy appearance of images by simulating film grain based on the content of the message. This method provides large bit-rate savings for high quality applications where the film grain is to be preserved. However, it increases decoders complexity since film grain has to be reproduced and blended to the decoded images as specified by the transmitted information.

According to this invention, we propose a method for simulating film grain in the frequency domain by mosaicing a series of pre-computed samples. This method avoids the generation of film grain for blending with every processed block of pixels from the input image. As a result, it strongly reduces the computational complexity of the film grain simulation process.

D. Discussion of how you or others have implemented similar things in the past, including the manner in which others have attempted to solve the problem. Point out disadvantages and weaknesses in previous practice. Include literature references where available

Film grain simulation has been implemented in several commercially available products as Cineon, trademark of Eastman Kodak Co., and Grain Surgery from Visual Infinity Inc.. These film grain simulation tools are commonly used in post-production to blend computer-generated objects into natural scenes with low constraints on complexity.

The efficient implementation of film grain simulation algorithms became a topic of interest only recently since the adoption of proposal [2] in the Professional Amendment of the H.264 standard. The standardization of an SEI message conveying film grain parameters will force all H.264 video decoders willing to support that SEI message to implement film grain simulation algorithms. However, at the best of our knowledge, no public literature exits describing efficient implementations of the specified algorithms.

E. **Description of the invention, including one or more practical embodiments of the invention in sufficient detail to allow one with ordinary skill in the art to practice the invention. Include schematic(s), flow chart(s) and or figures to clarify operation of the invention. Point out important features and items you believe to be new. State advantages of the invention and sacrifices, if any, made to achieve these advantages. Describe any experiments conducted and the results of those experiments**

BACKGROUND ART

According to the technique described in [1,2,3], film grain can be simulated on a block basis as illustrated in Figure 1. In a first step, the input image without film grain is decomposed in non-overlapping blocks of NxM pixels. Blocks are then read in raster-scan order until the whole image is scanned. Each of these blocks originates a block of film grain. Note that because the film grain characteristics may vary depending on the intensity level, the algorithm may select a different set of parameters depending on the average intensity measured on the extracted block. In a particular embodiment, the set of parameters will be conveyed in an SEI message as proposed in [1,2]. The set of film grain blocks generated through this process is stored and organized to form a film grain image that maps the size of the original input image. This composition process is what we have called mosaicing.

Figure 2 depicts the steps of the process that results in the generation of a block of NxM film grain samples. The first step consists in generating a block of NxM random values. A Discrete Cosine Transform (DCT) is then computed to obtain the corresponding NxM frequency coefficients. Note that other transforms could also be used within the same scheme. The frequency filtering of this set of coefficients, computed as specified in [6], controls the size of the simulated grain. Finally, the last step consists in computing the Inverse Discrete Cosine Transform (IDCT) of the modified set of coefficients. This process requires the specification of the noise deviation as well as the high and low cut frequencies that control the filtering process in the frequency domain. According to [1,2,3], such information could be conveyed in an SEI message for video coding applications.

Film grain blending with the original image is then performed as illustrated in Figure 3. Because individual blocks of film grain have been generated independently, artifacts can be perceived at the transitions between blocks. Thus, an optional filtering stage is introduced to reduce the visual artifacts resulting from the film grain mosaicing.

DESCRIPTION OF THE INVENTION

In this invention, we propose an efficient implementation of the film grain simulation algorithm previously described. In particular, we propose to limit the film grain generation to a pool creation process in which a limited number of film grain blocks are computed. This approach avoids the generation of film grain for blending with every processed block of pixels from the input image. As a result, we strongly reduce the computational complexity of the film grain simulation process.

Different embodiments of this invention are possible depending on whether the pool is created prior to the film grain insertion or whether it is created and further updated depending on the input image statistics. We describe some of these embodiments below.

Pool creation pr c ss implement d as an initialization step

The pool creation process, as illustrated in Figure 4, consists in generating a set of K blocks of film grain samples for each set of parameters in the SEI message. Let us remember that according to [3], different sets of parameters could be sent for different color components and different intensity levels. A particular implementation with K=1 will result in the lowest computational requirements, generating only one block of film grain per set of parameters. However, to avoid the creation of patterns, the use of a larger number of blocks or even the use of a different number of blocks for different intensity intervals is strongly recommended.

Following the pool creation process, information from the SEI message is not further required to assist the mosaicing process that creates the film grain image. As illustrated in Figure 5, film grain generation is now avoided by directly selecting a pre-computed block of film grain from the pool. When more than one block is available for the same intensity level and color component, a selecting criterion should be specified. In a particular implementation, the system could pseudo-randomly select one of the blocks from the pool to avoid the creation of patterns when a reduced number of blocks is available. Along these lines, the mosaicing process could make use of transformed copies of the set of available film grain blocks in a similar approach to that described in [5].

According to this implementation, the pool creation process is completely decoupled from the film grain blending stage. Despite of the computational advantages of anticipating the film grain generation, this approach has the inconvenient of being unaware of whether the input images will make use of all the blocks stored in the pool. The following approach allows a better management of the available memory based on the statistics of the input images.

Pool creation and update based on input image statistics

In a particular embodiment, the pool creation process could be performed based on the input image statistics. In this case, the computation of film grain blocks is not done a priori on all the possible intensity intervals described by the SEI message. Instead, the pool creation and/or update are done depending on the input image statistics, as illustrated in Figure 6.

Following this flowchart, when blocks in the pool are available, the algorithm avoids the computation of new film grain samples. However, if no blocks are available in the pool for a specific intensity interval, the algorithm proceeds to the computation of a new film grain block that becomes part of the pool. The algorithm may estimate that blocks are not available not only when the pool is empty, but also if the existing blocks have been recently used for blending. Other criteria for managing the pool creation and update process could also be envisaged.

An algorithm in accordance with this invention could progressively create and/or update the pool depending on the statistics of the input images. For example, the algorithm could organize the pool in order to dispose of a larger number of blocks in to those intensity intervals that are most used, to avoid the creation of visual patterns. According to this strategy, the distribution of film grain blocks in the pool could be progressively adapted to match variations in the image statistics (the sequence darkens or lightens).

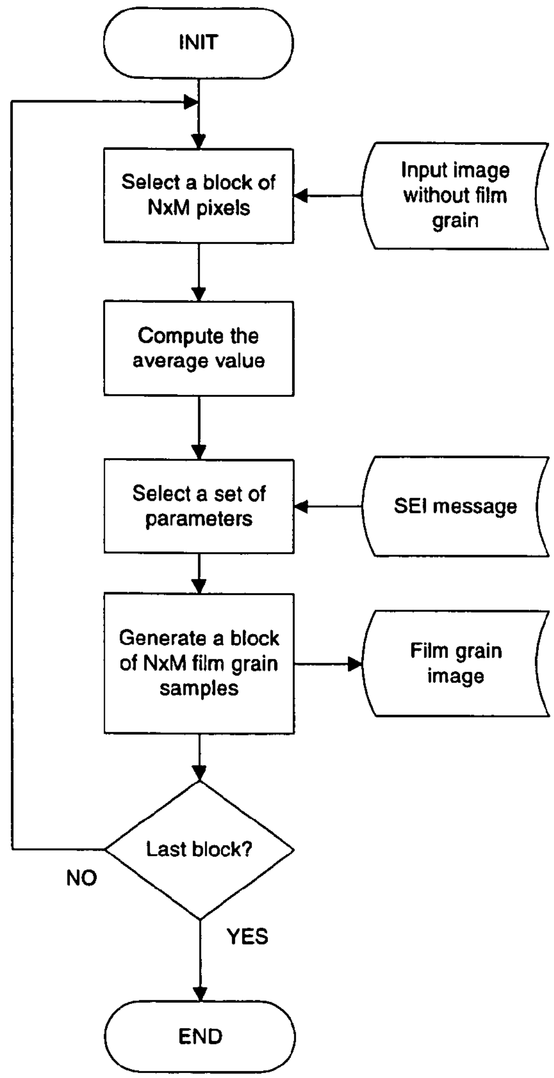

Figure 1. - Film grain simulation at the decoder end based on the mosaicing of blocks of NxM film grain samples generated by filtering in the frequency domain.

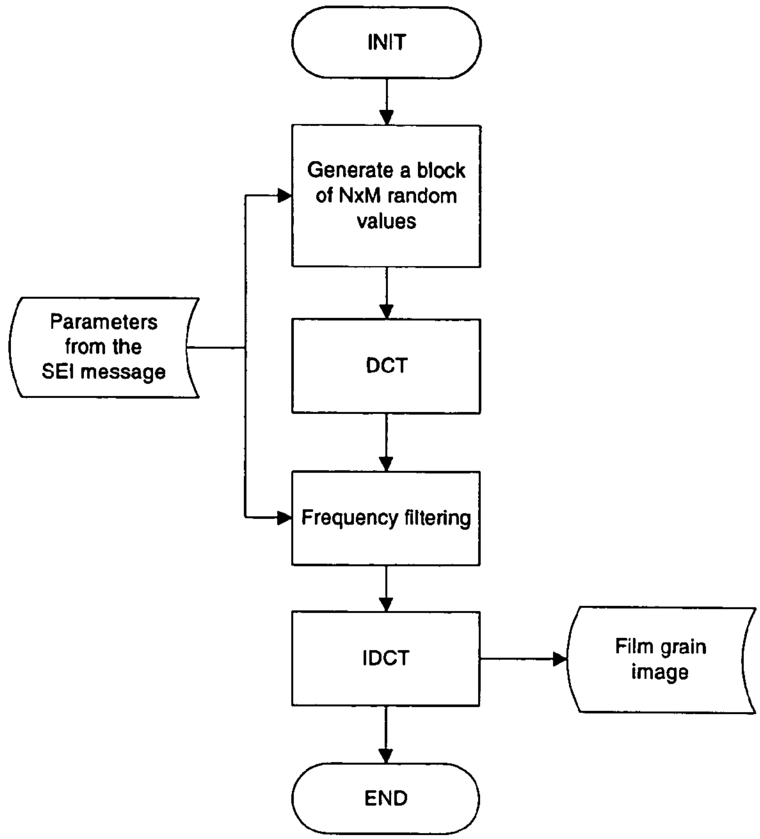

Figure 2. - Generation of NxM film grain samples in the frequency domain.

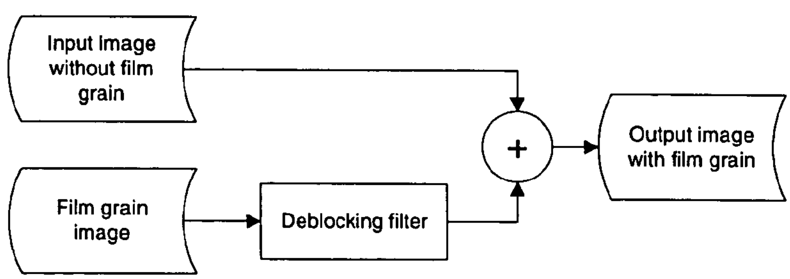

Figure 3. - Film grain blending at the decoder with an optional filtering stage introduced to reduce the visual artifacts resulting from the film grain mosaicing.

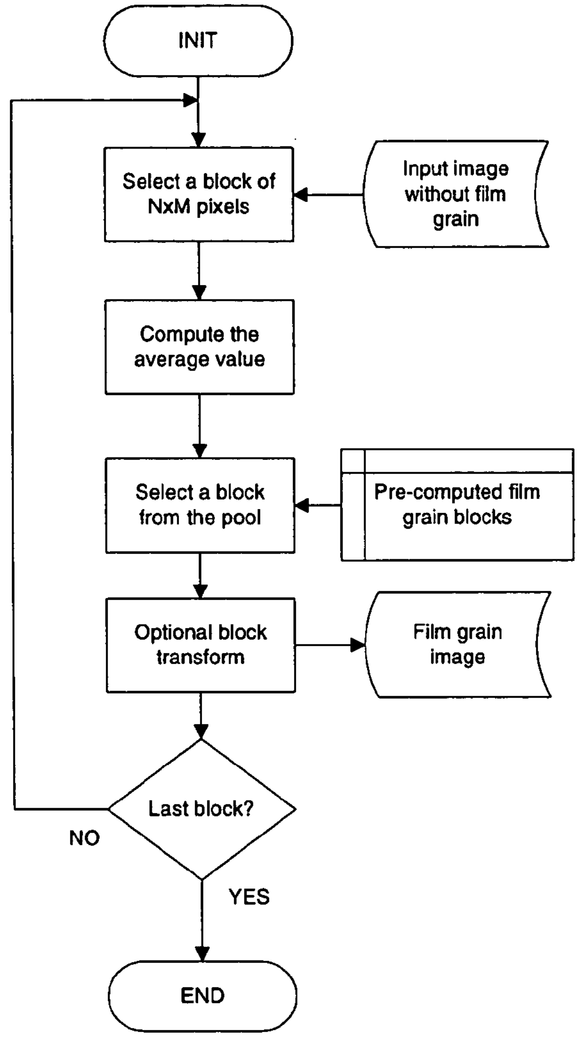

Figure 5. - Film grain simulation at the decoder end based on the mosaicing of pre-computed blocks of film grain samples as described by this invention.

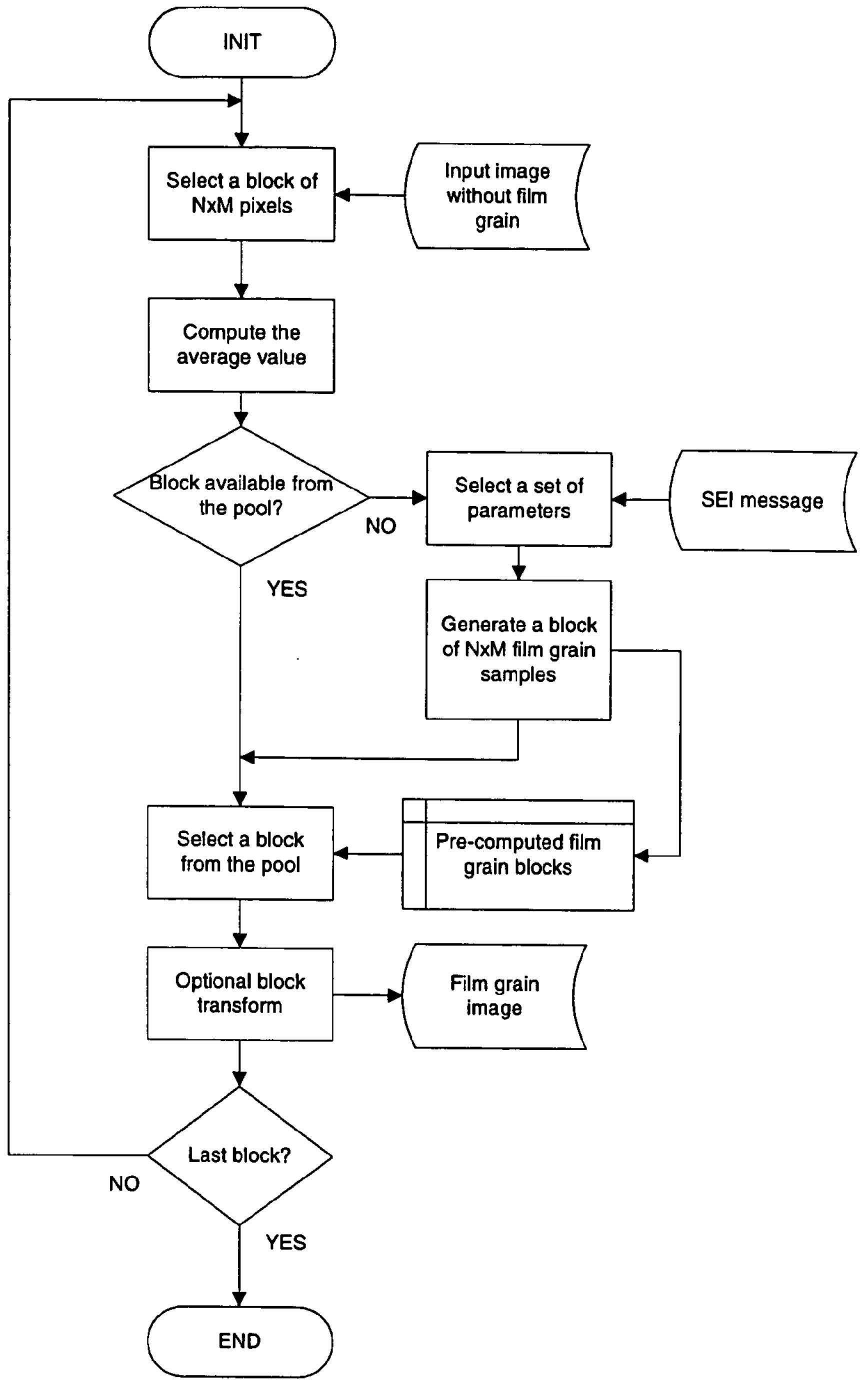

Figure 6. - Pool creation and update based on the statistics of the input images.

R fer nc s

[1] C. Gomila, "SEI message for film grain encoding", contribution JVT-H022, 8th JVT Meeting, Geneva, Switzerland, 23-27 May, 2003.

[2] C. Gomila, " SEI message for film grain encoding: syntax and results", contribution JVT-I013r2, 9th JVT Meeting, San Diego, California, USA, 2-5 September, 2003.

[3] C. Gomila and A. Kobilansky, "Apparatus for representing signal-dependent film grain noise by a set of parameters", provisional patent application PU03xxxx.

[4] C. Gomila and J. Boyce, "A method for simulating film grain on encoded video sequences", provisional patent application PU030116.

[5] M. Schlockermann, S. Wittman and T. Wedi, "Film grain coding in H.264/AVC", contribution JVT-I034, 9th JVT Meeting, San Diego, California, USA, 2-5 September, 2003.

[6] C. Gomila and J. Llach, " Method allowing automatic film grain modeling in the frequency domain ", provisional patent application PU03xxxx.

Possible claims

1. A method for simulating film grain by mosaicing a series of pre-computed samples.
2. Claim 1 where the pre-computed film grain samples are organized in a pool.
3. Claim 2 where the pool generation process is conceived as an initialization step in which film grain blocks are computed before blending.
4. Claim 2 where the pool is dynamically created and/or updated depending on the input image statistics.
5. Claim 2 where the pool provides different film grain samples for different color components and/or different intensity levels.
6. Claim 2 where transformed versions of the computed blocks of film grain are also used in the mosaicing process.